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Schleicher et al.

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[54] **MOVABLE FLUID DISPENSER WITH AIR BUBBLE DETECTORS FOR CONTROLLING DISPENSER MOVEMENT**

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[21] Appl. No.: **830,195**

[22] Filed: **Feb. 18, 1986**

[51] **Int. Cl.**[4] **B67D 5/34**; B67D 5/06

[52] **U.S. Cl.** **222/63**; 222/638; 137/173; 118/688

[58] **Field of Search** ..... 222/52, 61, 638, 72, 222/63; 356/410; 250/573; 604/65, 67, 253; 128/DIG. 13, DIG. 12; 137/173, 174, 177, 183; 340/603, 627, 632, 609; 209/657; 118/688

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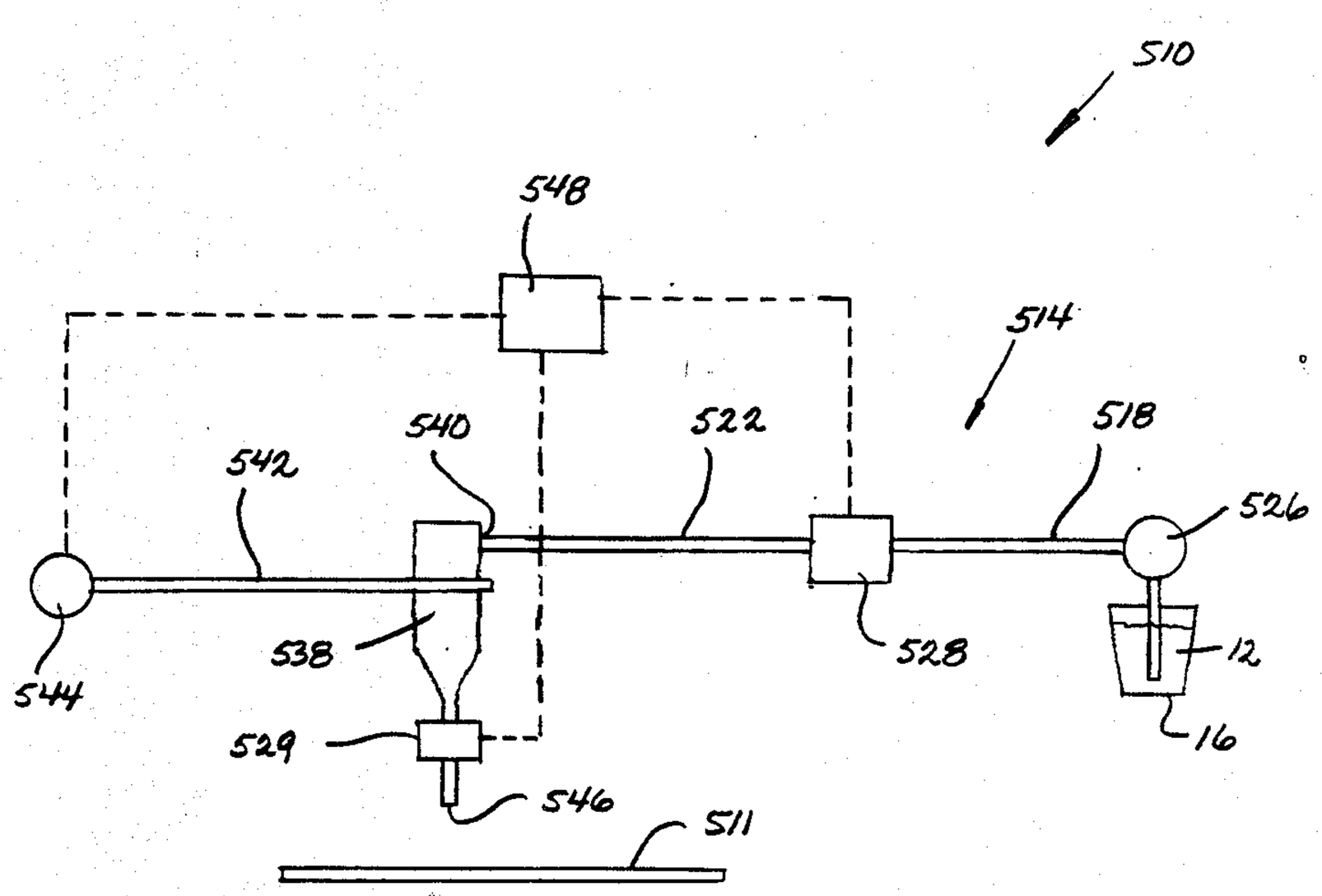
[57] **ABSTRACT**

An apparatus for dispending a fluid free of included air bubbles, such as for example, an adhesive bead, includes sensing devices for detecting the presence of an included air bubble in the conduit leading from a source of the fluid to a discharge of a movable fluid dispenser. The sensing devices are connected to a motor which drives an arm on which the fluid dispenser is mounted. A first sensing device slows movement of the dispenser upon sensing an air bubble in the fluid and a second sensing device stops movement of the dispenser upon sensing an air bubble in the fluid. The movement of the dispenser is restarted after a predetermined time period sufficient to allow the air bubble to pass out of the dispenser discharge. The sensing devices advantageously use a light beam, such as infra-red light or laser, to detect the presence of the included air bubble.

3 Claims, 7 Drawing Figures



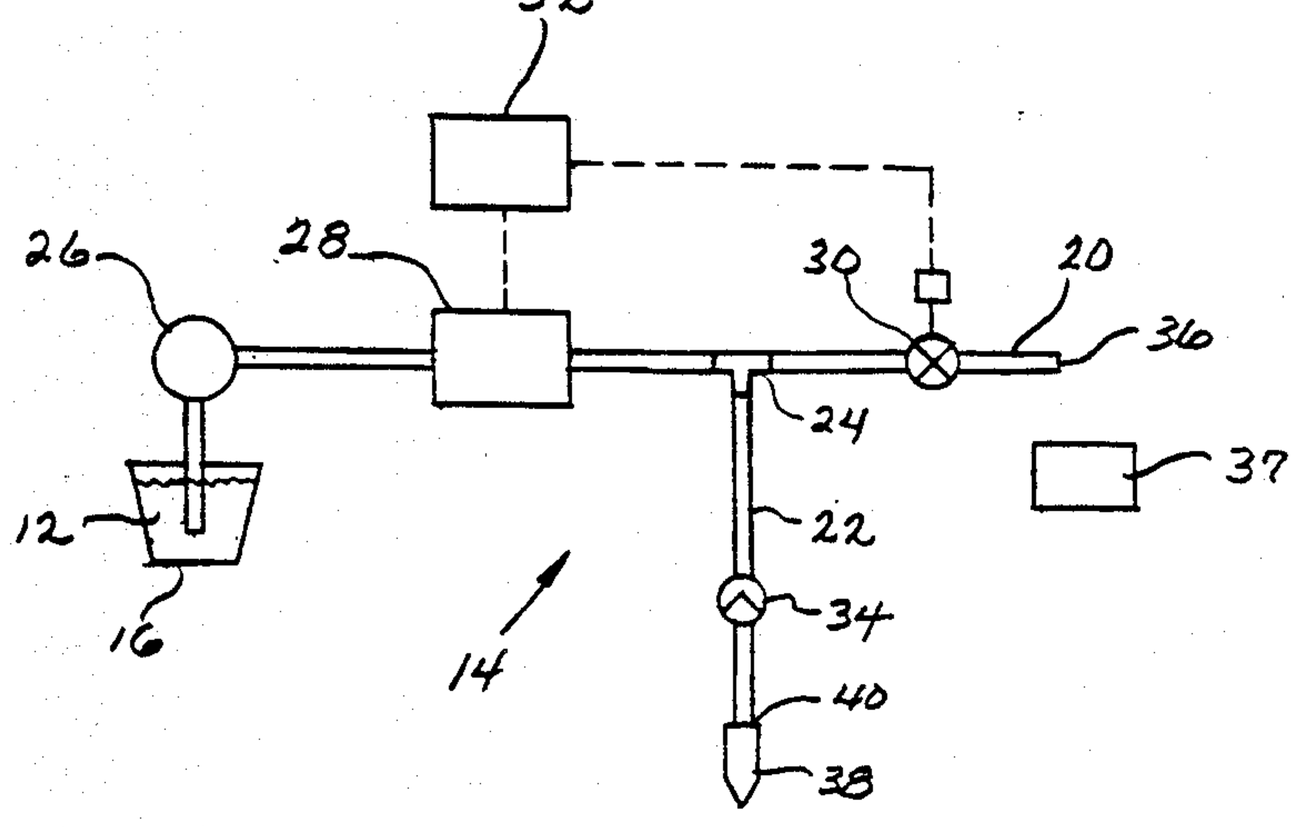

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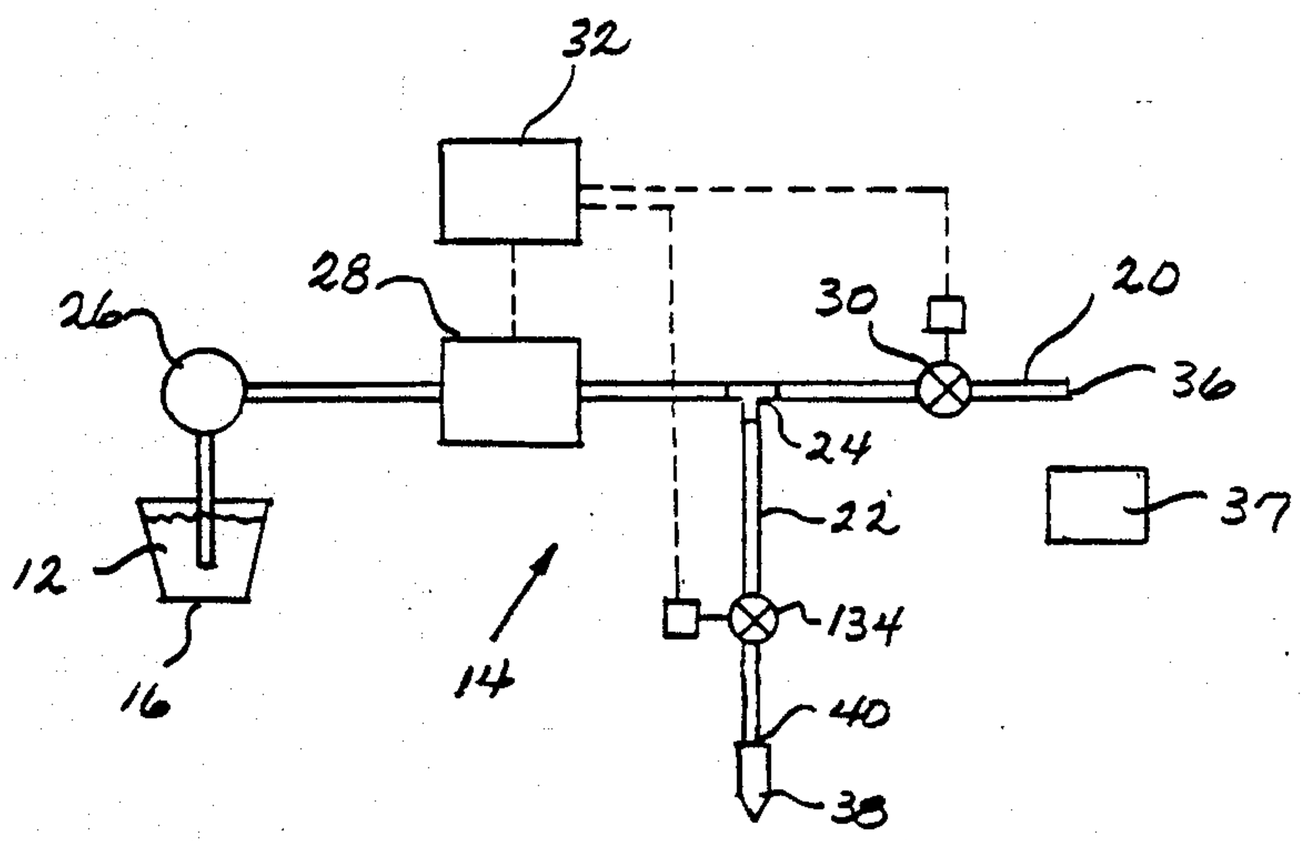
FIG. 1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12
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134
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38

FIG. 2

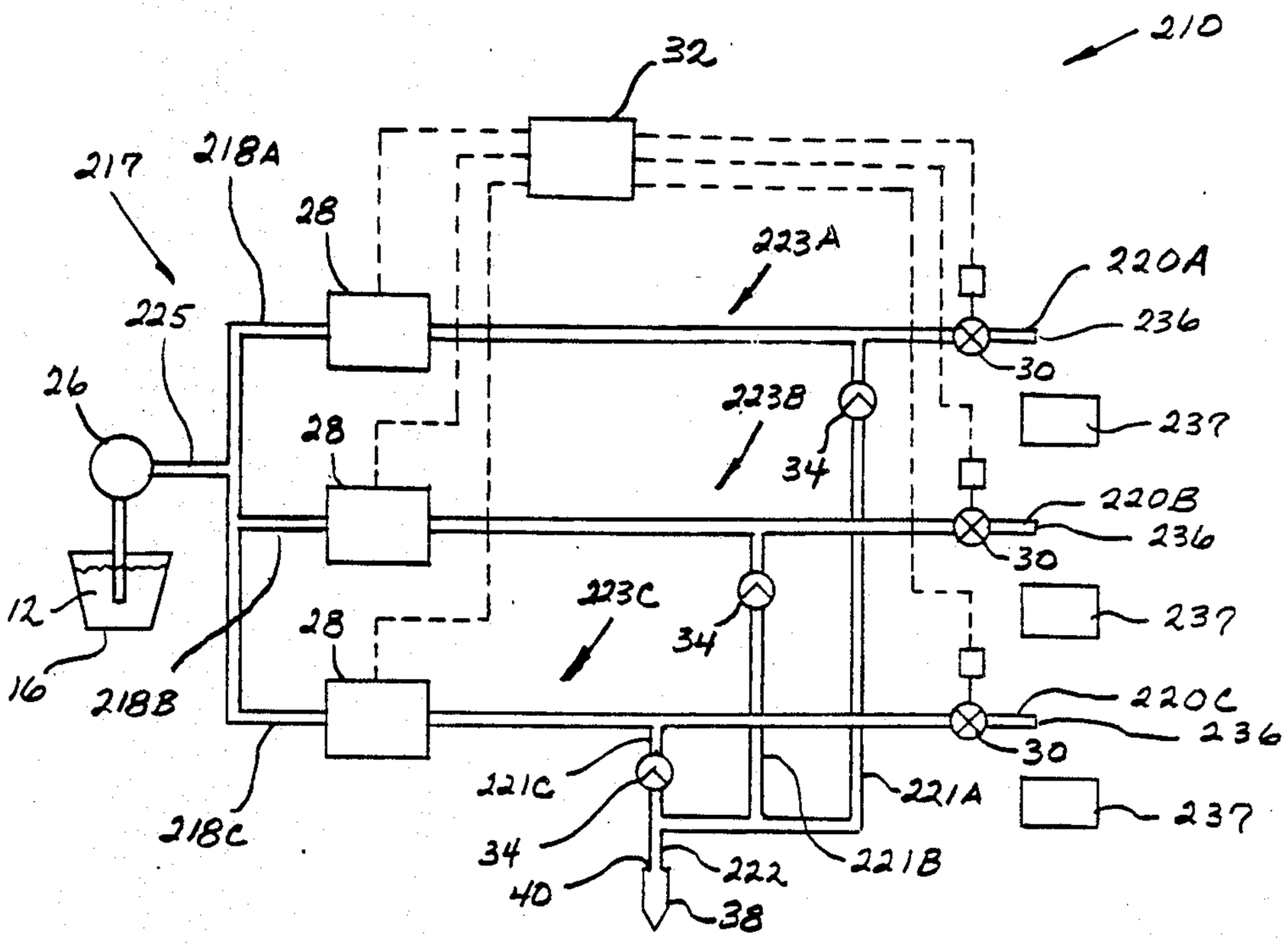
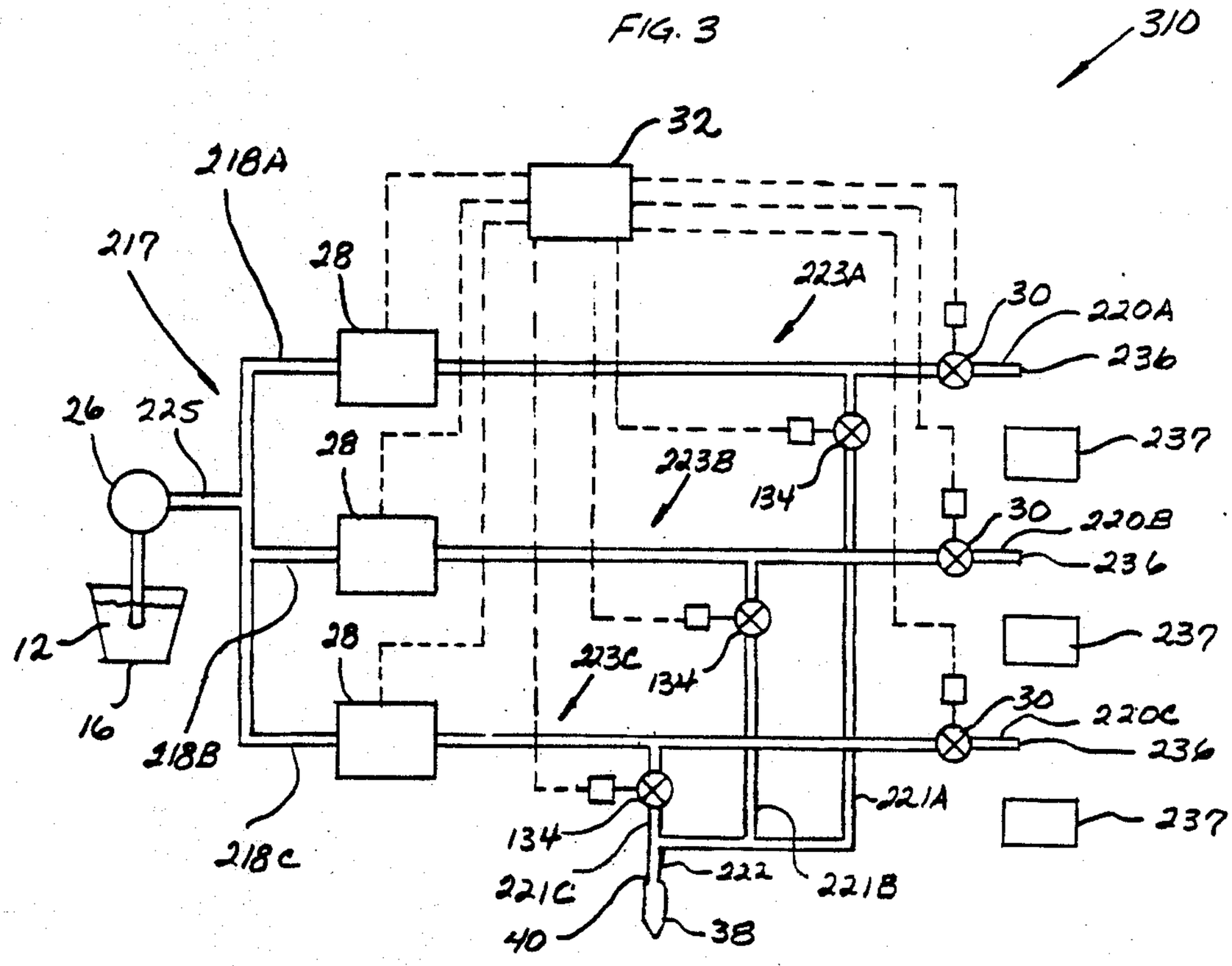

210
32
217
218A
28
223A
220A
225
236
30
26
223B
237
34
28
220B
12
223C
34
28
237
220C
16
218B
236
30
121C
221A
237
218C
34
222
221B
40
38

FIG. 3


310
32
218A
217
28
223A
30
220A
236
26
225
28
223B
237
134
30
220B
12
236
28
237
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220C
16
218B
236
221A
237
134
221C
222
221B
40
38

FIG. 4

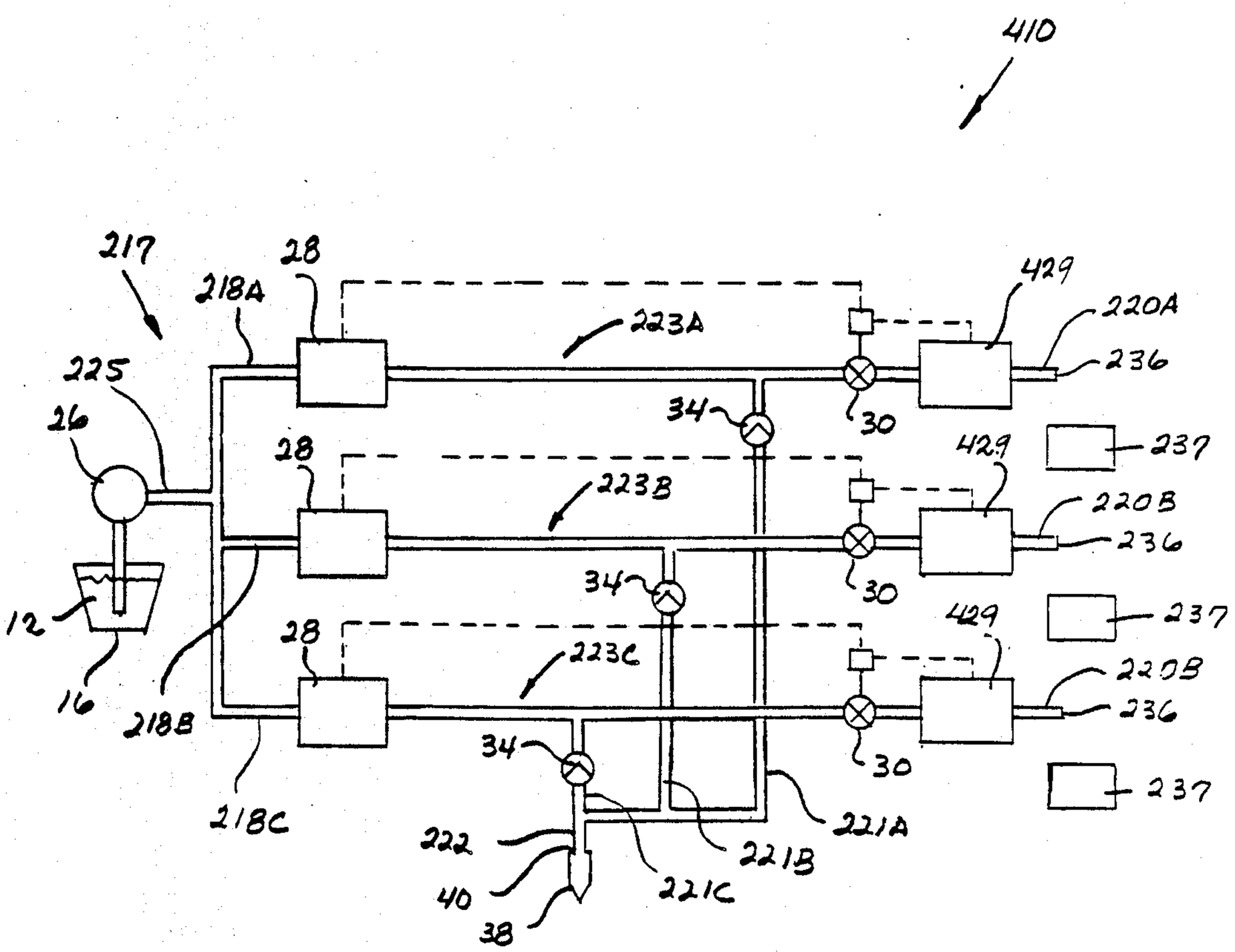
410
217
218A
28
223A
429
220A
236
225
26
34
30
237
223B
220B
12
16
218B
223C
218C
222
40
38
221A
221B
221C

FIG. 5

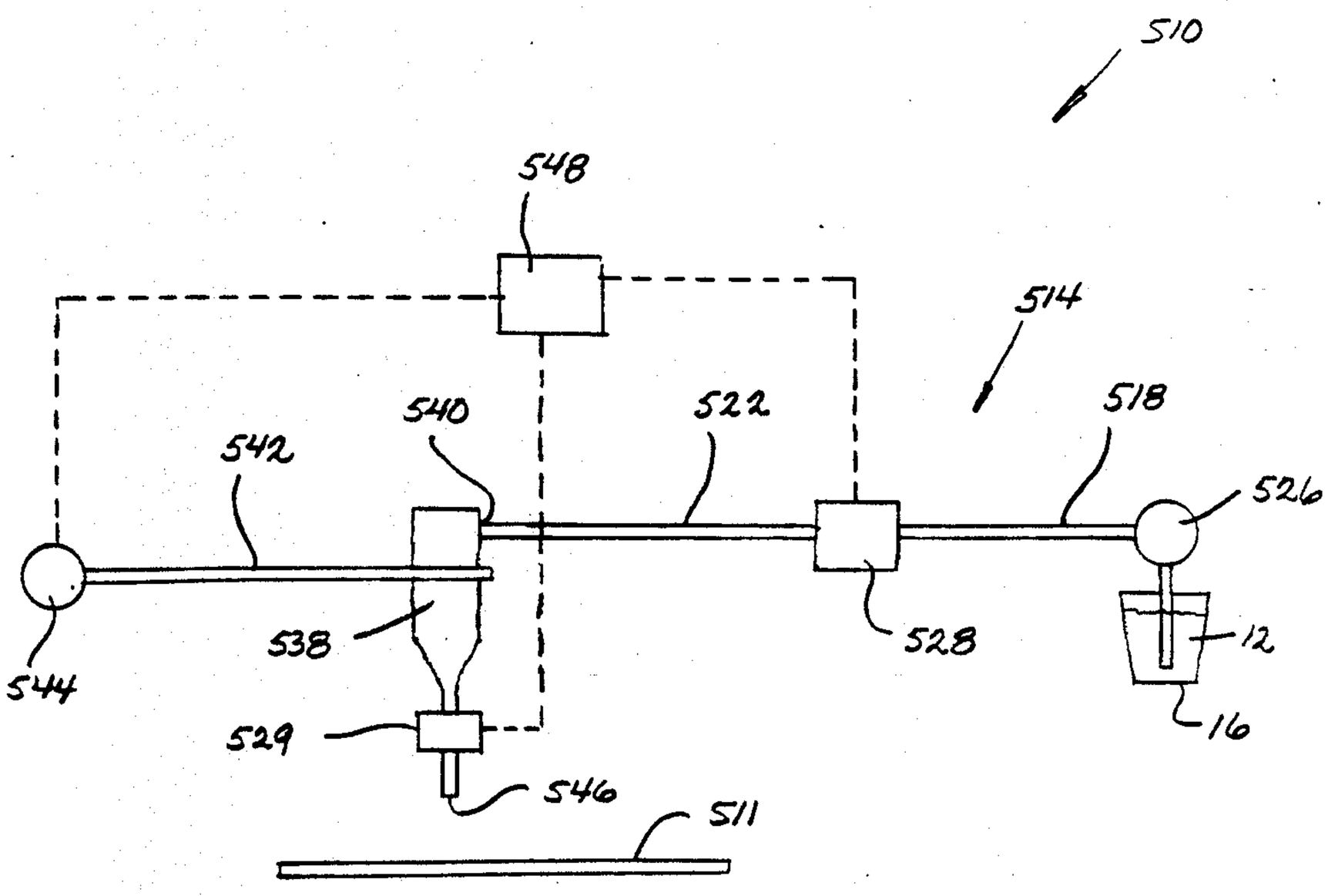
510
548
514
540
542
522
518
526
544
538
528
12
529
546
16
511

FIG. 6

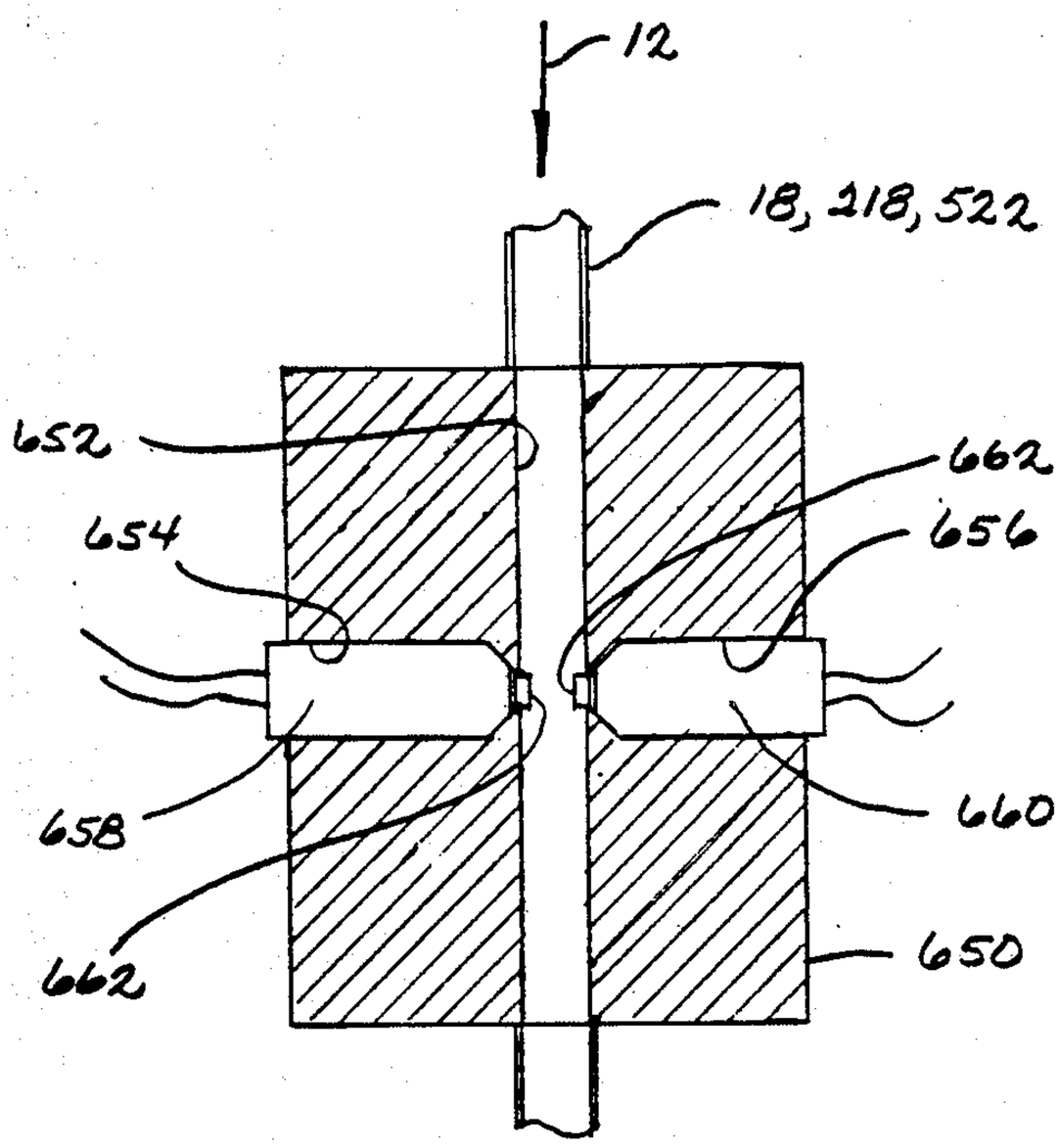

FIG. 7

MOVABLE FLUID DISPENSER WITH AIR BUBBLE DETECTORS FOR CONTROLLING DISPENSER MOVEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to the field of detectors and detecting by light, and more particularly to apparatus for dispensing a fluid including gas infusion detecting means and means for the elimination of the gas.

2. Discussion of the Prior Art

As presently contemplated, the present invention has an immediate practical use in applying a bead of adhesive to a workpiece. However, it should be made eminently clear at the point that the present invention is not limited to applying an adhesive bead to a workpiece.

In enumerable situations, the presence of a gas bubble in a liquid has drawbacks.

In the medical field, for example, a hazard associated with the infusion of liquids into a patient is the presence of gas, such as air bubbles, in the liquid.

In manufacturing, it has now become a common practice to attach to components of a product together with an adhesive material instead of welding. The presence of a gas bubble, for example, air in the applied adhesive results in a location of a weak bond between the workpiece components.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus for dispensing a fluid which provides not only for the detection of a gas bubble in a fluid, but also for the elimination of the gas bubble without interruption to the dispensing of liquid free of included gas bubbles.

It is another object of the present invention to provide an apparatus for dispensing a fluid which provides for the detection of a gas bubble in the fluid being dispensed and elimination of the gas bubble and, therefore, the potentially adverse void created by the gas bubble in the dispensed fluid.

It is yet another object of the present invention to provide an apparatus for dispensing a fluid of the class described wherein the gas bubble is detected using light.

The present invention, in one advantageous embodiment, provides an apparatus for dispensing a fluid comprising a source of the fluid, conduit means through which the fluid is transferred from the fluid source, means for moving the fluid from the source through the conduit means, means for sensing the presence of a gas bubble included in the fluid moving through the conduit means and means responsive to the sensing means for bleeding the gas bubble from the fluid moving through the conduit means.

The present invention, in another advantageous embodiment, provides an apparatus for dispensing a fluid comprising a source of fluid, conduit means through which the fluid is transferred from the liquid source, means for moving the fluid from the fluid source through the conduit means, means for sensing the presence of a gas bubble included in the fluid moving through the conduit means, and means responsive to the sensing means for bleeding the gas bubble from the fluid moving through the conduit means without interruption to the flow of fluid not having an included gas bubble.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and objectives of the present invention will become even more clear upon reference to the following description in conjunction with the accompanying drawings in which like numerals refer to like parts throughout and wherein:

FIG. **1** is a schematic representation of one embodiment of the apparatus of the present invention for dispensing a fluid;

FIG. **2** is a schematic representation of another embodiment of the apparatus of the present invention for dispensing a fluid;

FIG. **3** is a schematic representation of yet another embodiment of the apparatus of the present invention.

FIG. **4** is a schematic representation of still another embodiment of the apparatus of the present invention;

FIG. **5** is a schematic representation of a further embodiment of the apparatus of the present invention;

FIG. **6** is a schematic representation of yet a further embodiment of the apparatus of the present invention; and

FIG. **7** is a cross-sectional view of a gas bubble sensing device which is a component of the apparatus of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. **1**, there is shown an apparatus, generally denoted as the numeral **10**, of the present invention for dispensing a fluid **12**. As shown, the apparatus **10** includes conduit means, generally denoted as the numeral **14**, in flow communication with a source **16** of fluid **12**.

The conduit means **14** is shown as having a fluid inlet branch **18**, a fluid bleed branch **20** in flow communication with the inlet branch **18**, and a fluid dispensing branch **22** in flow communication with the inlet branch **18**. The inlet, bleed and dispensing branches are shown as intersecting at a T-fitting **24**. The inlet branch **18** is connected to a fluid pump **26** located at the fluid source **16** for moving the fluid **12** from the source **16** through the conduit means **14**.

The apparatus **10** includes gas bubble sensing means, generally denoted as the numeral **28**, for sensing the presence of a gas bubble included in the fluid moving through the conduit means **14**. The gas bubble sensing means **28** is located in the fluid inlet branch **18** of the conduit means **14** for sensing an included gas bubble before the gas bubble would reach the fluid dispensing branch **22** and the fluid bleed branch **20** of the conduit means **14**.

Bleed valve means denoted as the numeral **30** is located in the fluid bleed branch **20** for opening and closing the fluid bleed branch **20**. The bleed valve means **30** is operatively associated with the gas bubble sensing means **28** so that the bleed valve means **30** will open and close in response to the sensing or detection of an included gas bubble by the sensing means **28**. When the sensing means **28** detects an included gas bubble in the fluid flowing in the fluid inlet branch **18** of the conduit means **14**, it causes the bleed valve means **30** to open allowing the portion of the fluid having the included gas bubble to flow through the fluid bleed branch **20** of the conduit means **14** bypassing the fluid dispensing branch **22**. After the included gas bubble has passed the bleed valve means **30**, the bleed valve means **30** is closed so that fluid not having an included gas bubble will flow to

the fluid dispensing branch **22** of the conduit means **14**. Toward this objective, timer means **32** is associated with the bleed valve means **30** and the gas bubble sensing means **28**. The timer means **32** closes the bleed valve means **30** after a predetermined time measured from the time the sensing means **28** opens the bleed valve means **30** sufficient to allow the included gas bubble detected by the sensing means **28** to pass the open bleed valve means **30** so that fluid not having an included gas bubble will move through the fluid dispensing branch **22**.

In addition, as shown, the apparatus **10** has a fluid check valve means **34** located in the fluid dispensing branch **22** of the conduit means **14**. The check valve means **34** prevents the back flow of pressurized fluid already in the dispensing branch **22** into the bleed branch **20** when the bleed valve means **30** is open.

The bleed branch **20** is open at a discharge end **36** downstream of the bleed valve means **30** to a reservoir **37** for waste fluid which had included gas bubbles bleed from the apparatus **10**.

The fluid dispensing branch **22** has, for example, a dispensing nozzle device **38** at its discharge end **40** for controlling the discharge of the fluid.

With reference to FIG. **2**, there is shown an apparatus, generally denoted as the numeral **110**, which is a somewhat modified version of the apparatus **10** of FIG. **1**. Therefore, the components in common between the apparatus **10** and **110** are denoted by the same numerals and the description therof will not be repeated for the sake of brevity. The main difference between the apparatus **10** and **110** is that the check valve **34** has been replaced by a shut-off valve **134** operatively associated with the sensing means **28** to open and close in response to the detection of an included gas bubble detected by the gas bubble sensing means **28**. Toward this end, the shut-off valve **134** is also interconnected with the timer means **32**. In operation, when the sensing means **28** causes the bleed valve means **30** to open, it also causes the shut-off valve **134** to close thus preventing the flow of fluid into the fluid dispensing branch **22** of the conduit means **14**. After the predetermined time has elapsed, the timer means **32** closes the bleed valve means **30** and concurrently opens the shut-off valve **134** to allow the flow of fluid through the fluid dispensing branch **22**.

It is contemplated that the bleed valve means **30** and shut-off valve means **134** can be replaced by an equivalent three-way valve means located at the intersection of the intersection of the inlet branch **18**, fluid bleed branch **20** and dispensing branch **22** at the location of the T-fitting **24**. The three-way valve means would also be operatively associated with the timer means **32** to open and close the bleed branch **20** and dispensing branch **22** as described in relationship to the bleed valve means **30** and shut-off valve means **134** as discussed above.

With reference to FIG. **3**, there is shown an apparatus, generally denoted as the numeral **210**, of the present invention for dispensing a fluid **12** which includes the same principles as the apparatus **10** of FIG. **1**.

The apparatus **210** includes conduit means **214** in flow communication with the source **16** of the fluid **12**. The conduit means **214** comprises a manifold system, generally denoted as the numeral **217**, having a plurality of fluid inlet branches **218A**, **218B**, **218C**, fluid bleed branches **220A**, **220B**, **220C**, and fluid discharge branches **221A**, **221B**, **221C**. Each fluid discharge branch **221** is in flow communication with a different one of the fluid inlet branches **218**, and each one of the fluid bleed conduits **220** is in fluid flow communication with a different one of the fluid inlet branches **218**, and each one of the fluid bleed conduits **220** is in fluid flow communication with a different one of the fluid inlet branches **218**. For example, the manifold system **217** comprises three stems **223A**, **223B**, and **223C**. The first stem **223A** comprises the fluid inlet branch **218A**, the fluid bleed branch **220A**, and the fluid discharge branch **221A** in mutual flow communication; the second stem **223B** comprises the fluid inlet branch **218B**, the fluid bleed branch **220B** and the fluid discharge branch **221B** in mutual flow communication; and the third stem **223C** comprises the fluid inlet branch **218C**, the fluid bleed branch **220C**, and the fluid discharge branch **221C** in mutual flow communication. The inlet, bleed and discharge branches of each manifold stem **223A**, **223B** and **223C** intersect at a T-fitting. The fluid inlet branches **218A**, **218B** and **218C** are interconnected through a common fluid feed branch **225** to fluid pump **26** located at the fluid source **16** for moving the fluid **12** from the source **16** through the conduit means **214**, and the manifold stems **223A**, **223B** and **223C** are disposed in parallel fluid flow relationship. Therefore, fluid **12** is concurrently moved through all of the manifold stems **223A**, **223B** and **223C**. The fluid discharge branches **221A**, **221B** and **221C** are interconnected to a common fluid dispensing branch **222** which will dispense fluid flowing through any one, or any combination of the manifold stems **223A**, **223B** and **223C**.

Each of the manifold stems **223A**, **223B** and **223C** includes gas bubble sensing means **28** for sensing the presence of a gas bubble included in the fluid moving through each manifold stem **223A**, **223B** and **223C**. Preferably, there is sensing means **28** disposed in each one of the fluid inlet branches **218A**, **218B** and **218C** for sensing an included gas bubble before the gas bubble would reach the fluid dispensing branch **222**, and more particularly, before it would reach the fluid discharge branches **221A**, **221B** and **221C** of the conduit means **214**.

Bleed valve means **30** is located in each of the fluid bleed branches **220A**, **220B**, **220C** for independently opening and closing the fluid bleed branches **220A**, **220B**, **220C**. Each bleed valve means **30** is operatively associated with the gas bubble sensing means **28** which is located in the same manifold stem **223** so that the bleed valve means **30** will open and close in response to the sensing or detection of an included gas bubble by the sensing means **28**. When a sensing means **28** detects an included gas bubble in the fluid flowing in the fluid inlet branch **218**, it causes the bleed valve means **30** to open allowing the portion of the fluid having the included gas bubble to flow through the fluid bleed branch **220** by-passing the fluid dispensing branch **222**. After the included gas bubble has passed the bleed valve means **30**, the bleeed valve means **30** is closed so that fluid not having an included gas bubble will flow through the fluid branch **221** to the dispensing branch **222**. Toward this objective, timer means **32** is associated with each bleed valve means **30** and each bubble sensing means **28**. The timer means **32** closes the bleed valve means **30** after a predetermined time measured from the time the sensing means **28** opens the bleed valve means **30** sufficient to allow the included gas bubble detected by the sensing means **28** to pass the open bleed valve means **30** so that fluid not having an included gas bubble will move through the fluid dispensing branch **222**.

In addition, as shown, the apparatus **210** has fluid check valve means **34** located in each of the fluid discharge branches **221A, 221B, 221C** of each manifold stem **223A, 223B, 223C**. The check valve means **34** prevents the back flow of pressurized fluid already in the fluid discharge branch **221** into the bleed branch **220** when the bleed valve means **30** is open.

Each bleed branch **220A, 220B, 220C** is open at a discharge end **236** downstream of the bleed valve means **30** to a reservoir **237** for waste fluid which had included gas bubbles bleed from the apparatus **210**.

The fluid dispensing branch **222** has, for example, a dispensing nozzle device **38** at its discharge end **40** for controlling the discharge of the fluid.

In operation of the apparatus **210**, when included gas bubbles are detected in the fluid flowing in any of the manifold stems **223A, 223B, 223C**, the sensing means **28** in that manifold stem will cause the bleed valve means **30** in that manifold stem to open to bleed the gas bubble from the system through the bleed branch **220A, 220B, 220C** of that manifold stem thus preventing the fluid having the included gas bubble from flowing through the fluid discharge branch **221A, 221B, 221C** in that manifold stem to the common fluid dispensing branch **222**. However, fluid not having an included gas bubble flowing in the other manifold stems **223A, 223B, 223C** will continue to flow to the common fluid dispensing branch **222** so that there is no interruption to the flow of fluid through the apparatus **210** to be dispensed.

With reference to FIG. **4**, there is shown an apparatus **310** which is a somewhat modified version of the apparatus **210** of FIG. **3**. Therefore, the components in common between apparatus **210** and **310** are denoted by the same numerals and the description thereof will not be repeated for the sake of brevity. The main difference between the apparatus **210** and **310** is that the check valve means **34** in each of the fluid discharge branches **221A, 221B, 221C** have been replaced by a shut-off valve **134** operatively associated with the sensing means **28** to open and close in response to the detection of an included gas bubble detected by the gas bubble sensing means **28** located in the same manifold stem **223A, 223B, 223C**. Toward this end, the shut-off valve **334** is also interconnected with the timer means **32**. In operation, when the sensing means **28** causes the bleed valve means **30** to open, it also causes the shut-off valve **334** in the same manifold stem **223A, 223B, 223C** to close, thus preventing the flow of fluid through the fluid discharge branch **221A, 221B, 221C** and into the fluid dispensing branch **222** of the conduit means **214**. After the predetermined time has elapsed, the timer means **32** closes the bleed valve means **30** and concurrently opens the shut-off valve **334** to allow the flow of fluid to the fluid discharge branch **221A, 221B, 221C** to the common fluid dispensing branch **222**.

It is contemplated that the bleed valve means **30** and shut-off valve means **134** in each manifold stem **223A, 223B** and **223C** be replaced by an equivalent three-way valve means located at the intersection of the fluid inlet branch **218**, fluid bleed branch **220** and fluid discharge branch **221** of the manifold stem **223**. The three-way valve means would also be operatively associated with the timer means **32** to open and close the bleed branch **220** and discharge branch **221** as described in relationship to the bleed valve means **30** and shut-off valve means **134** as discussed above.

FIG. **5** illustrates an apparatus generally denoted as the numeral **410** which has many features and components in common with the apparatus **210** of FIG. **3** and apparatus **310** of FIG. **4**. The common features and components are denoted by identical numerals and the description thereof will not be repeated for the sake of brevity.

The main difference between the apparatus **410** and the apparatus **210** and **310** is that the timer means **32** is eliminated. In place of the timer means **32** for closing the bleed valve means **30**, the apparatus **410** uses second gas bubble sensing means **429** located in each fluid bleed branch **220A, 220B, 220C**. Each second gas bubble sensing means **429** is positioned downstream of the bleed valve means **30** and is operatively connected to the bleed valve means **30** in the same fluid bleed branch **220A, 220B, 220C**.

In operation, when the first gas bubble sensing means **28** detects an included gas bubble in the fluid flowing through the fluid inlet branch **218A, 218B, 218C** it causes the bleed valve means **30** in the same manifold stem **223A, 223B, 223C** to open, as discussed in regard to the embodiments of FIGS. **3** and **4**, to bleed the portion of the fluid having the included gas bubble through the fluid bleed branch **220A, 220B, 220C**. The second gas bubble sensing means **429** detects the passing of the included gas bubble, and after it has passed the second gas bubble sensing means **429**, the second gas bubble sensing means **429** causes the bleed valve means **30** to close. If the shut-off valve means **134** of the apparatus **310** is also included in the apparatus **410** instead of check valve means **34**, the second bubble sensing means **429** is also operatively associated with the shut-off valve means **134** so that after the included gas bubble has passed the second gas bubble sensing means **429**, it also causes the shut-off valve means **134** to open.

FIG. **6** illustrates an apparatus, generally denoted as the numeral **510**, for dispensing fluid to a workpiece **511**. The apparatus **510** includes conduit means, generally denoted as the numeral **514**, in flow communication with a source **16** of fluid **12**.

The conduit means **514** is shown as having a fluid inlet branch **518** and a fluid dispensing branch **522**. The fluid inlet branch **518** is connected to a fluid pump **526** located at the fluid source **16** for moving the fluid **12** from the source **16** through the conduit means **514**.

A fluid dispensing nozzle device **538** is located at the discharge end **540** of the fluid dispensing branch **522** for controlling the dispensing of the fluid on the workpiece **511**. The fluid dispensing nozzle device **538** is mounted for movement along a predetermined path over the workpiece **511**. Therefore, the fluid dispensing branch **522** should be relatively long and of flexible construction. The dispensing nozzle device **538** can be mounted to a movable manipulating arm **542** and the manipulating arm **542** is driven along the predetermined path by, for example, electric motor **544**. The movable manipulating arm **542** and drive motor **544** arrangements are known in the art and will, therefore, not be further discussed here.

It is an objective of the apparatus **510** to stop movement of the movable arm **542** when there is an included gas bubble in the fluid being dispensed to prevent a void in the fluid dispensed on the workpiece **511**. However, it has been determined that due to the momentum of typical moving arms **542** that it is virtually impossible to immediately stop the arm **542**. Toward this objective and to overcome this problem, the apparatus **510** includes first bubble sensing means **528** located in the fluid dispensing branch **522** upstream of the dispensing noz-

zle device **538** and second bubble sensing means **529** located immediately upstream of the discharge **546** of the nozzle device **538**. Both first and second gas bubble sensing means **528** and **529** are operatively associated through appropriate controls **548** to the electric motor **544** driving the movable arm **542**. When the first bubble sensing means **528** detects an included gas bubble in the fluid moving in the dispensing branch **522** to the nozzle device **538** it causes the electric drive motor **544** to slow, thus, slowing the movement of the arm **542**. The included gas bubble initially detected by the first bubble sensing means **528** continues to move with the fluid through the nozzle device **538** to the nozzle discharge **546** whereat the second bubble sensing means **529** detects the included gas bubble and causes the motor **544** to stop, thus, stopping movement of the arm **542**. The motor control **548** also includes timer means for restarting the electric motor **544** driving the arm **542** after a predetermined length of time sufficient to allow the included gas bubble to pass through the nozzle discharge **546** so that when the arm **542** resumes movement fluid free of included gas bubbles is being dispensed to the workpiece, thereby preventing voids in the fluid dispensed to the workpiece.

With reference to the above discussed apparatus, the bleed valve means **30** and shut-off valve means **134** can be solenoid activated valves. Also, the timer means **32** would also include an amplifier to amplify the signal from the gas bubble sensing means **28**.

FIG. **7** illustrates an advantageous embodiment of a gas bubble sensor **28**, **429**, **528**, **529** used in the above-described apparatus **10**, **210**, **310**, **410** and **510** of the present invention. As shown, the gas bubble sensor includes a housing **650** formed with a flow-through passage **652** for fluid flow through the housing **650**. The diameter of the passage **652** is smaller than the bore of the fluid conduits of the fluid conduit means of the above-described apparatus. A bore **654** is formed through the housing **650** open to one side of the passage **652** and another similar bore **656** is formed through the housing **650** open to the other side of the passage **652**. The openings of the bores **654** and **656** are in alignment with each other across the diameter of the passage **652**. A light source **658** is located in one of the bores, for example, bore **654**, to direct light across the passage **652**. A light sensor **660** is located in the other one of the bores, for example, bore **656**, to receive the light eminating from the light source **658**. The light source **658** may be of the type generating, for example, an ultra-violet light, infra-red light, or a laser generated light. The wave length of the light will depend to an extent on the type of fluid to be passed through the sensor device. The light transmission characteristics of the fluid flowing in the passage **652** will, of course, change as a gas bubble included in the fluid **12** passes between the light source **658** and light sensor **660**. This change may be a change in the brightness of the light passing from the light source **658** to the light sensor **660**. In some applications, the fluid is abrasive. In order to protect the light source **658** and light sensor **660** from the abrasive fluid, a lens **662** is placed over the opening of each bore **654** at the flow-through passage **652**. It has been determined that a lens **662** made of sapphire works well.

The foregoing detailed description is given primarily for clearness of understanding and no unnecessary limitations should be understood therefrom for modifications will become obvious to those skilled in the art upon reading this disclosure and may be made without departing from the spirit of the invention or scope of the appended claims.

What is claimed is:

1. An apparatus for dispensing a fluid comprising:

a source of fluid;

conduit means in flow communication with the fluid soruce;

means for moving the fluid from the source through the conduit means;

dispensing means having a fluid discharge associated with the conduit means for controlling the dispensing of fluid from the conduit means;

means for moving the dispensing means along a predetermined path;

first means for sensing the presence of a gas bubble included in the fluid moving through the conduit means upstream of the dispensing means, the first sensing means being operatively associated with the dispensing means moving means for slowing the movement of the dispensing means when an included gas bubble is sensed by the first sensing means; and,

second sensing means for sensing the presence of a gas bubble included in the fluid moving in the dispensing means upstream of the fluid discharge of the dispensing means, the second sensing means being operatively associated with the dispensing means moving means for stopping the movement of the dispensing means when an included gas bubble is sensed by the second sensing means.

2. The apparatus of claim **1**, further comprising timer means operatively associated with the dispensing means moving means for restarting the dispensing means moving means after a predetermined time, measured from the time the second sensing means senses an included gas bubble, sufficient to allow the included gas bubble to pass out of the discharge of the dispensing means.

3. The apparatus of claim **1** wherein each of the first and second gas bubble sensing means comprises:

a light source disposed for directing a beam of light across the moving fluid; and,

a light sensor disposed for receiving the beam of light from the light source across the moving fluid.

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